

## CLAIMS

What is claimed is:

1. A system for monitoring, measuring, and/or usage metering of a vehicle involving tracking continuous movement and position of said vehicle comprising:
  - 5     • an apparatus mounted on or in the vehicle, comprising:
    - a receiver for receiving positioning signals;
    - a motion detector;
    - an RFID and/or DSRC element;
    - a processor for forming a continuous, time-marked position-log from the positioning
    - 10     signals, comprising a memory;
    - a storage element; and
    - a two-way wireless telecommunication element, such as GPRS, to transmit position-logs;
  - a central processing system comprising:
    - 15     • a central telecommunication element to demand, receive and acknowledge receipt of position-logs and system information from the apparatus;
    - digital maps and databases for containing usage fees, premium rules, parking fees and schedules;
    - a central processor to further process position-logs, calculate user fees and
    - 20     generate invoices, maps and data feeds; and
    - a central storage element.
2. The system of claim 1 wherein the receiver receives one or more positioning signals comprising at least one type of signal from the group represented by GPS, GNSS, Galileo, GLONASS, and Loran.
- 25 3. The system of claim 2 wherein the positioning signals further includes a type which is boosted, corrected, differenced or retransmitted location signals for resolving reception problems including multipath, shadow, scatter, and ionospheric disturbance.
4. The system of claim 1 wherein:
  - position-logs are sent encrypted and on a scheduled and/or demand basis from the
  - 30     vehicle to the central processing system;
  - the central processing system and the apparatus comprises means to determine whether the apparatus is operating correctly.

- the processor uses a protocol to ensure that all data is received by the data center before reusing memory on the apparatus; and
  - position-logs are transmitted to the central processing facility using a redundant methodology; wherein the wireless telecommunication element can substitute DSRC or equivalent wireless communication to off-load position-logs on an opportunistic basis to a receiving station other than the central processing system for subsequent non-wireless transmission to the central processing system, thereby avoiding GPRS usage for that transmission.
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5. The system of claim 1 wherein:
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- parking usage can be metered and assessed for user fees;
  - road usage can be metered and assessed for user fees;
  - road usage can be metered and assessed for pay-as-you-drive insurance premiums;
  - spatial maps of usage volumes and/or congestion may be generated for planning, managing or reporting; and
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- data feeds comprising usage, volumes, and/or congestion information may be generated for control, management, reporting and feedback;
6. The system of claim 5 wherein the processor:
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- determines whether the vehicle is parked, moving, or standing (part of a normal journey);
  - marks each segment of the position-log as a parking episode or a journey segment;
  - filters and compresses each parking episode or journey-log according to its special characteristics;
  - manages the storage of compressed position-logs until forwarded;
  - manages the forwarding of position-logs to the central processing system.
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7. The system of claim 6, wherein additional processing for optimal accuracy contingent on whether the position-log segment is a parking episode or a journey segment comprising application-independent statistical methods, or GPS-specific methods.
8. The system of claim 6 wherein the processor extracts and compresses a parking episode by using a combination of the state of the motion detector and filtering related to signal stationarity to determine the temporal end-points of the parking episode.
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9. The system of claim 6 wherein the processor in the vehicle apparatus extracts and compresses journey-logs using the Douglas-Peucker (DP) line compression algorithm, as

modified by retaining time-stamp information and injecting an optimally compressed congestion-log for congestion-related pricing, navigation, control, and mapping applications, and allowing for extraction of a pure position-only track-log subset exactly matching the standard DP line compression.

- 5    10. The system of claim 5 wherein parking-prices are calculated by determining whether a parking episode has taken place within a parking spot where fees are payable according to a digital map and over a sufficient time period during which fees are payable according to rules stored in a parking-fee and schedule database.
11. The system of claim 5 wherein road-prices are calculated by determining whether a  
10    journey segment has taken place on a roadway where fees are payable according to a digital map, the event time, the length of time, and the degree of congestion during the journey segment according to rules stored in a usage-fee and schedule database.
12. The system of claim 11 wherein the degree of congestion during the journey segment is calculated by using at least one or both of:
  - 15    • a congestion-log information from a journey segment;
  - a congestion-log from at least one co-located and co-temporal vehicle by applying statistical pattern recognition techniques to resolve any positional ambiguities related to the exact lane a vehicle was traveling in during the journey segment.
13. The system of claim 5 wherein insurance-prices are calculated for a journey segment by  
20    determining whether the journey segment has taken place on a roadway where premiums are payable according to location on a digital map, the starting time, the length of time, and the degree of congestion during the journey segment according to rules stored in an insurance-premium database.
14. The system of claim 5 wherein the central data system retains all pricing information,  
25    digital maps, and fee schedule rule databases in order to apply flexible, highly responsive policy changes that effect graduated prices, locations, and times including pricing calculations that may incorporate the congestion behaviour experienced at the time of the journey.
15. The system of claim 14 wherein the databases may be modified in real-time for setting or  
30    calculating graduated location, graduated time, and graduated pricing with respect to changing pricing policies and transport demands;

16. The system of claim 5 that provides for optional, on-demand transmission of position-logs for the urgent purpose of adjustment of a financial record, acquisition of congestion information, location of a vehicle for emergency purposes, or for the purpose of pricing for service vehicles such as taxis, comprising:

- A central processing system-to-vehicle request-respond protocol
- A vehicle-to-data center send-interrupt protocol
- a radio communication interface to a separate in-vehicle sub-system for receiving a signal to inject artificial break-points in a journey-log for starting and stopping a position-log and triggering an upload to the central data processing system for documenting a usage price in real-time.

17. The system of claim 5 wherein the central processing system initiates and receives real-time congestion-log transmission for generating real-time navigation feeds and realtime traffic signal control feeds.

18. The system of claim 5 wherein vehicle identification information and position-log information is encrypted in such a way that no person other than the vehicle registrant, using a decryption key, may gain access to any elements of the position-logs.

19. The system of claim 1 wherein the apparatus carries out failover using an redundant wireless 2-device network mounted in the vehicle for informing the central processing system while continuing to collect position-logs if one device fails or is excluded from service.

20. A method for monitoring, measuring, and/or usage metering of a vehicle involving tracking continuous movement and position of said vehicle, comprising the following steps:

- using a mobile communication device mounted on a vehicle to perform steps comprising the following:
  - receiving signals for generating a position-log for a vehicle;
  - determining for each element of the position-log whether it is part of a journey-log or a parking episode;
  - marking the beginning and end of each journey-log segment and parking episode
  - applying distinct compression methods for journey-log segments and parking episodes;
  - retaining compressed congestion information within the journey-log segments;
  - storing position-logs;

- sending the position-logs to a central processing system on a scheduled or demand basis;
- using the central processing facility to perform steps comprising the following:
  - scheduling, demanding, receiving and acknowledging transmissions from vehicles;
  - 5      • post processing of compressed position-logs for final error removal and data collation;
  - for each parking episode, establishing whether it was located in a subscribing parking spot and determining the parking fee payable; and
  - 10    • for each journey-log, determining any road-usage fee due and/or insurance premium due.